SYLLABUS

For

Master of Engineering Programmes
(M.Tech. Geotechnical Engineering)

(For admission in 2022-23 and onwards)
# Proposed Scheme of Examination of M. Tech. Programme for Specialization:

## Geotechnical Engineering

### Semester I

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### Semester II

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Semester IV

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Course objectives:

From this course, students will be able to:
1. learn distinct methods of solving simultaneous equations.
2. well-versed with partial differential equations and their solutions and applications.
3. acquire the knowledge of transformation to ease the complex problems.
4. acquaintance with basics of random variables and their distribution for dealing with events by chance.
5. study different mathematical domains to deal with real-time engineering problems.

Learning outcomes:

1. Comprehend with engineering problems in different mathematical realm.
2. Learn analytical and numerical methods to deal with mathematical problems.
3. Understand how to model the engineering problems and their solutions.
4. Implement the solutions to real-time complex engineering problems.
5. Apprehend with mathematical methodology.

Course content:

Unit I: Solution of linear simultaneous equations: (8 hours)

Consistency, Iterative method, Convergence, Cholesky’s (Crout’s) method, Gauss-Jordan method, Gauss-Seidel iteration and relaxation methods, Solution of Eigenvalue problems, Smallest, largest, and intermediate Eigen values

Computer based algorithm and programme for these methods (non-evaluative)

Unit II: Partial differential equation and its applications: (10 hours)

Introduction and classification of partial differential equation, Four standard forms of non-linear partial differential equations and their solutions, linear equations with constant coefficients. Applications of partial differential equationsone and two-dimensional wave equation, one and two-dimensional heat equation, Two-dimensional Laplace’s equation.
Syllabus
Advanced Mathematics (AHT-301)

L:T:P:: 3:1:0

Credits-4

Unit III: Transform calculus-I:
(Laplace transform, Properties of Laplace transform, Inverse Laplace transform, Applications of Laplace transform, Fourier integral theorem, Fourier transforms, Application of Fourier transform)

Unit IV: Transform calculus-II:
(Z-transform, Properties of Z-transform, Shifting theorems, Initial and final value theorem, Convolution theorems, Inverse Z-transform, Application of Z-transform)

Unit V: Basic probability theory:
(Concept and laws of probability, Discrete and continuous random variable and their distributions, Some special distributions such as Binomial, Poisson, Negative Binomial, Geometric, Continuous uniform, Normal, Exponential, Weibull, Moments, Moment generating functions, Expectation and variance)

Practical demo with statistical software like R, SPSS, SAS, etc. (non-evaluative)

Text Books / References:
Course Objectives: Objectives of introducing this subject at first year level in Masters of civil engineering are:

- To understand the engineering properties of soil and identify the problematic soils.
- To evaluate the soil shear strength for different types of soil and in different conditions of weather.
- To analyse the soil behavior under loading and the stresses developed within soil mass for saturated and unsaturated conditions.
- To apply the knowledge of soil compressibility and consolidation theory in practice to estimate settlement.

Course Outcomes:
After the completion of this course, the student will be able to:

2. Get a detailed idea about the pore water pressure due to undrained loading and seepage.
3. Get detailed information about consolidation in soil media.
4. Get a clear idea about shear stress and stress paths.
5. Understand the concept of Critical State Soil mechanics.

Syllabus:
UNIT-I (8 hours)
Compressibility of Soils: Consolidation theory (one-, two-, and three-dimensional consolidation theories), consolidation in layered soil and consolidation for time dependent loading, determination of coefficient of consolidation (Casagrande method and Taylor’s method).

UNIT-II (8 hours)
Strength Behavior of Soils: Mohr Circle of Stress; UU, CU, CD tests, drained and undrained behavior of sand and clay, significance of pore pressure parameters; determination of shear strength of soil; Interpretation of triaxial test results.

UNIT-III (8 hours)
Stress Path: Drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations.

UNIT-IV (8 hours)
Critical State Soil Mechanics: Critical state parameters; Critical state for normally, consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surface; drained and undrained plane. Critical void ratio; effect of dilation in sands; different dilation models.

UNIT-V (8 hours)
Elastic and Plastic Deformations: elastic wall; introduction to yielding and hardening; yield curve and yield surface, associated and non-associated flow rule.
Syllabus

ADVANCED SOIL MECHANICS (CET –601 )

L: T: P: 3:1:0

Credits-4

Text Book:

Reference books:
Syllabus

SOIL DYNAMICS (CET – 602)

3L: 1T:0P   Credits-4

Course Objectives:

- Study theory of vibrations for their application to solve dynamic soil problems.
- Calculate the dynamic properties of soils using laboratory and field tests.
- Study the phenomenon of liquefaction.
- Analyze and design machine foundations by Barkan’s theory and elastic half space concept.
- Analyze and design vibration isolation systems.

Course Outcomes:

After the completion of this course, the student will be able to:

1. Understand the causes and quantification of earthquake.
2. Assess properties of soil effected by seismic wave propagation.
3. Design Ground Motion at a Site and Dynamic Response Analysis.
4. Determine the dynamic soil properties using various field tests (Standard penetration test, plate load test, block vibration test, SASW/MASW tests. etc).
5. Evaluate soil liquefaction potential.

Syllabus:

Introduction: Background and lessons learnt from damages in past earthquakes, Internal Structure of the Earth, Continental Drift and Plate Tectonics, Elastic Rebound Theory, Geometric Notation, Location of Earthquakes, Size of Earthquakes.

UNIT-II Wave Propagation: Waves in unbounded media in one- and three-dimensional wave propagation; Waves in semi-infinite media; Waves in a layered medium; Attenuation of stress waves - material and radiation damping.

UNIT-III Dynamic Soil Properties: Stress & strain conditions, concept of stress path, Measurement of seismic response of soil at low and high strain; Field tests - Seismic reflection, Seismic refraction, Steady-state vibration (Rayleigh Wave) test, Standard penetration test; Laboratory tests- Shaking table, Centrifuge tests and determination of soil-spring constant - cyclic plate load and block vibration test; Stress-strain behaviour of cyclically loaded soils; Evaluation of damping and shear modulus; Effect of strain level on the dynamic soil properties.


UNIT-V Liquefaction: Introduction, liquefaction related phenomena – flow liquefaction and cyclic mobility, Factors affecting liquefaction, liquefaction susceptibility; historical criteria, geological criteria, compositional criteria, State Criteria; Evaluation of liquefaction potential, cyclic stress ratio, cyclic
Syllabus

SOIL DYNAMICS (CET – 602)

3L: 1T:0P Credits-4

Resistance ratio, Effects of liquefaction.

Text Book:

Reference books:
Syllabus

GROUND IMPROVEMENT TECHNIQUES (CET – 603)

3L: 0T:0P Credits-3

Course objectives:
· To impart knowledge of various problems associated with soil deposits and various methods to evaluate them.
· To impart knowledge of different techniques to improve the characteristics of soil.
· To impart knowledge of design techniques required to implement various ground improvement methods.

Course Outcomes:
After the completion of this course, the student will be able to:
1. Identify the necessity of ground improvement.
2. Understand the different types of ground modification can be done depending upon the site condition, type and purpose of structure to be constructed.
3. Understand the functions of geosynthetics and soil nailing in engineering constructions.

Syllabus:

UNIT-I                                                                                                                               (8 hours)
Introduction: Situations where ground improvement becomes necessary.

UNIT-II                                                                                                                             (8 hours)
Mechanical Modification: Dynamic compaction, impact loading, compaction by blasting, vibro-compaction; pre-compression, stone columns; Hydraulic modification: dewatering systems, preloading and vertical drains, electro-kinetic dewatering.

UNIT-III                                                                                                                             (8 hours)
Chemical Modification: Modification by admixtures, stabilization using industrial wastes, grouting

UNIT-IV                                                                                                                              (8 hours)
Soil Reinforcement: Reinforced earth, basic mechanism, type of reinforcements, selection of stabilization/improvement of ground using Geotextiles, Goegrid, geomembranes, geocells, geonets, and soil nails.

UNIT-V                                                                                                                                  (8 hours)
Application of Soil Reinforcement: Shallow foundations on reinforced earth, design of reinforced earth retaining walls, reinforced earth embankments structures, wall with reinforced backfill, analysis and design of shallow foundations on reinforced earth, road designs with geosynthetics

Text Book:
Syllabus

GROUND IMPROVEMENT TECHNIQUES (CET – 603)

3L: 0T:0P Credits-3

Reference books:
Syllabus

PAVEMENT ANALYSIS AND DESIGN (CET – 604)

3L: 0T:0P Credits-3

Course objectives:
- To provide students with the knowledge about the fundamental properties and behaviour of earth materials, mathematical models, and methods of analysis for different conditions.
- To provide students with in-depth analysis and design of common geotechnical structures and solutions to real problems.
- To provide students with practical knowledge of pavement material and pavement behavioural analysis.

Course Outcomes:
After the completion of this course, the student will be able to:
1. Design flexible as well rigid pavements.
2. Appreciate the functions of various components of a pavement.
3. Identify the factors affecting design of pavements.
4. Evaluate performance of pavement and design the overlay on flexible and rigid pavement.

Syllabus:

UNIT-I (8 hours)
Philosophy of design of flexible and rigid pavements.

UNIT-II (8 hours)
Analysis of pavements using different analytical methods.

UNIT-III (8 hours)
Selection of pavement design input parameters – traffic loading and volume

UNIT-IV (8 hours)
Material characterization, drainage, failure criteria, reliability, design of flexible and rigid pavements using different methods.

UNIT-V (8 hours)
Comparison of different pavement design approaches, design of overlays and drainage system.

Text Book:

Reference books:
Syllabus

COMPUTATIONAL GEOMECHANICS (CET-605)

Course Objectives:
The objective of this course is to introduce the student to modern numerical methods for the solution of coupled & non-linear problems arising in geo-mechanics / geotechnical engineering.

Course Outcomes:
After the completion of this course, the student will be able to:

1. Understand different numerical and statistical tools for analyzing various geotechnical engineering problems.
2. Apply probabilistic approach for selection of design parameters and compute their impact on risk assessment.

Syllabus:

UNIT-I                                                                                                                                          (8 hours)

UNIT-II                                                                                                                                          (8 hours)

UNIT-III                                                                                                                                        (8 hours)
Correlation and Regression Analysis: Correlation - Scatter diagram, Karl Pearson coefficient of correlation, Limits of correlation coefficient; Regression –Lines of regression, Regression curves, Regression coefficient, Differences between correlation and regression analysis.

UNIT-IV                                                                                                                                         (8 hours)
One-Dimensional Consolidation - Theory of consolidation, Analytical procedures, Finite difference solution procedure for multilayered systems, Finite element formulation.

UNIT-V                                                                                                                                           (8 hours)

Text Book:

Syllabus

COMPUTATIONAL GEOMECHANICS (CET-605)

3L: 0T:0P

Credits- 3


Reference books:

Syllabus

EARTHQUAKE RESISTANT DESIGN OF STRUCTURE (CET-606)

3L: 0T:0P
Credits-3

Course objectives:
- To Study the multimodal and multidirectional response spectrum analysis.
- To make students familiar regarding understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- To make students able to do seismic design and detailing of structures with reference to is code.

Course Outcomes:
After the completion of this course, the student will be able to:

1. Summaries engineering seismology and discuss the causes and effects of earthquakes.
2. Characterize different types of vibration for single degree freedom system.
3. Understand principle of vibration measuring instrument.
4. Analyze pulse or impulse loading using Duhamel’s Integral.
5. Draw the response spectra for different ground condition and understand their application.
6. Draw the node shape for multi degree freedom system using different methods.

Syllabus:
UNIT-I  (8 hours)
Introduction to Earthquake Parameters: Earthquake occurrences – Global Seismic Belts. Indian Seismic zoning map, their engineering implications: Damage survey, seismic intensity, isoseismal maps, and more commonly used earthquake parameters like epicenter, epicentral distance, origin time, focus, magnitude, and frequency. Elementary information on seismic wave propagation. Demonstration of seismographs to explain earthquake recording.

UNIT-II  (8 hours)

UNIT-III  (8 hours)
Single Degree of Vibration Freedom System: Vibration Measuring Instruments, (Demonstration for determination of damping, frequency etc.), Response of undamped systems to time dependent force functions (Pulse/impulses), Duhamel’s Integral, Response to ground motion, Response spectra.

UNIT-IV  (8 hours)
Two Degree of Freedom System: Determination of natural frequency and mode shapes, Steady state forced vibrations, Undamped vibration absorbers.


UNIT-V  (8 hours)
Earthquake Effects: Ground failures, Local site effects, Effects on ground and structure.

Introduction to IS Code: IS-1893, Codal Provisions for evaluation of earthquake forces on buildings.
Syllabus

EARTHQUAKE RESISTANT DESIGN OF STRUCTURE (CET-606)

Text Book:

Reference books:
Syllabus

SOIL STRUCTURE INTERACTION (CET-607)

3L: 0T:0P

Credits-3

Course objectives:
To learn various models used in the geotechnical engineering and its use during the analysis of soil-structure interaction problems.

Course Outcomes:
After the completion of this course, the student will be able to:
1. Apply different soil response models for specific problem based on the requirement.
2. Analyse footings/rafts resting on soil as beams/plates on elastic foundation and work out design bending moments/shear and displacements.
3. Compute pile response for various loading condition for design purpose.

Syllabus:
UNIT-I
Introduction to Earthquake Parameters: Earthquake occurrences –Global Seismic Belts. Indian Seismic Zoning.

UNIT-II

UNIT-III

UNIT-IV
Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

UNIT-V
Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. An introduction to soil-foundation interaction under dynamic loads.

Text Book:

Reference books:
SOIL STRUCTURE INTERACTION (CET-607)

3L: 0T:0P

Credits-3

Syllabus

FEM IN GEOMECHANICS (CET-608)

3L: 0T:0P Credits-3

Course objectives:
Objectives of introducing this subject at first year level in Masters of civil engineering are:
1. To enable student with fundamentals of Finite element method.
2. To impart the knowledge and skill of analyzing physical problems with FE software.

Course Outcomes:
After the completion of this course, the student will be able to:
1. Understand the fundamentals of Finite element method.
2. Impart the knowledge and skill of analyzing physical problems with FE software.
3. Understand the basic functions of FE based software and its applications in geotechnical engineering.
4. Select the appropriate element and mesh for FE analysis for given problem.
5. Evaluate the type of problem and develop the FE-model.
6. Estimate the stresses and strain in soil through FE analysis for given physical problem.

Syllabus:
UNIT-I Stress-Deformation Analysis: One dimensional, two dimensional and three-dimensional formulations. (8 hours)
UNIT-II Discretization of a Continuum: Elements, Strains, Stresses, Constitutive, Relations, Hooke’s Law, Formulation of Stiffness Matrix, Boundary Conditions. (8 hours)
UNIT-III Principles of Discretization: Element stiffness and mass formulation based on direct, variational and weighted residual techniques and displacements approach, Shape functions and numerical integrations, convergence. (8 hours)
UNIT-IV Displacement Formulation: For rectangular, triangular and iso-parametric elements for two dimensional and axisymmetric stress analyses. (8 hours)

Text Book:
2. Bathe K.J., “Finite element procedures”, PHI Ltd.
Syllabus

FEM IN GEOMECHANICS (CET-608)

3L: 0T:0P            Credits-3

Reference books:

Syllabus

ADVANCED SOIL MECHANICS LAB (CEP-601)

Course Objectives:

- Ability to evaluate various soil characteristics.
- Ability to measure shear strength of soil.
- Student will be familiar with ASTM laboratory test standards and procedures. This include preparing soil samples for testing, performing the test, collecting and analyzing data, interpreting the results and writing technical reports.

Course Outcomes:

After the completion of this course, the student will be able to:

1. Understand the procedure for classifying coarse grained and fine-grained soils.
2. Evaluate the index properties of soil.
3. Determine the engineering properties of soil.
4. Interpret the results of compaction test for relative compaction in the field.
5. Conduct experiments analyze and interpret results for geotechnical engineering design.
6. Compute and analyze the consolidation settlements.

Syllabus:

EXPERIMENTS:

1. To determination of Moisture Content and Specific gravity of soil
2. To determine the Grain Size Distribution Analysis and Hydrometer Analysis
3. To determine the Atterberg Limits (Liquid Limit, Plastic limit, Shrinkage limit)
4. To determine the Visual Classification Tests
5. To determine the Vibration test for relative density of sand
6. To determine the Standard and modified proctor compaction test
7. To determine the Falling head permeability test and Constant head permeability test
8. To determine the Consolidation test
9. To determine the Triaxial Shear Test (CU, CD, UU)
10. To determine the Field Density Test
SOIL DYNAMICS LAB (CEP-602)

Course objectives:
This course will enable students to facilities to work on the dynamic strength and stability of soils by evaluating dynamic soil properties, index properties of soils and liquefaction resistance of soils. Highly sensitive element test facilities.

Course Outcomes:
After the completion of this course, the student will be able to:
1. Calculate the dynamic properties of soils using laboratory and field tests.
2. Determine shear strength of soil using cyclic triaxial test and cyclic direct shear test.

Syllabus:

EXPERIMENTS:
1. To determine the Spectral analysis of surface waves (SASW) Test / Multi-channel analysis of surface waves (MASW) test
2. To determine the Seismic cross-hole test
3. To determine the Seismic down-hole / up-hole test
4. To determine the Seismic dilatometer test
5. To determine the Resonant column test
6. To determine the Piezoelectric bender element test
7. To determine the Cyclic triaxial test
8. To determine the Cyclic direct shear test
9. To determine the Block vibration test
Open Elective-1 (Optional) Disaster Management (CET-623)

Course objectives:

- The main objective of the topic is to create awareness about and understanding of disasters and disaster mitigation measures. It deals with the subject in a structured manner.
- The topic classification of disasters, separate chapters on natural and man-made (anthropogenic) disasters, basic management concepts, four-cycle disaster management, organizational structures in India and other countries, NGOs, ethical issues and case studies.

Course Outcomes:

After the completion of this course, the student will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Syllabus:

UNIT-I                                                                                                    (8 hours)
Introduction Disaster: Definition, factors and significance; difference between hazard and disaster; natural and manmade disasters: difference, nature, types and magnitude. Repercussions of disasters and hazards: economic damage, loss of human and animal life, destruction of ecosystem. natural disasters: earthquakes, volcanisms, cyclones, tsunamis, floods, droughts and famines, landslides and avalanches, man-made disaster: nuclear reactor meltdown, industrial accidents, oil slicks and spills, outbreaks of disease and epidemics, war and conflicts.

UNIT-II                                                                                                      (8 hours)
Disaster Prone Areas in India: Study of seismic zones; areas prone to floods and droughts, landslides and avalanches; areas prone to cyclonic and coastal hazards with special reference to tsunami; post-disaster diseases and epidemics.

UNIT-III                                                                                                          (8 hours)
Disaster Preparedness and Management: Preparedness: monitoring of phenomena triggering a disaster or hazard; evaluation of risk: application of remote sensing, data from meteorological and other agencies, media reports: governmental and community preparedness.

UNIT-IV                                                                                                          (8 hours)
Syllabus

Open Elective-1 (Optional) Disaster Management (CET-623)

3L: 0T:0 Credits-3


UNIT-V (8 hours)
Disaster Mitigation meaning, concept and strategies of disaster mitigation, emerging trends in mitigation. Structural mitigation and non-structural mitigation, programs of disaster mitigation in India.

Text Book:
2. Sahni, PardeepEt.Al. (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall Of India, New Delhi.

Reference books:
Technical Writing and Presentation Skills (AHT-303)

L:T:P::2:0:0 Non-credits

Course Objectives:
- To develop effective writing and presentation skills in students.
- To develop textual, linguistic and presentation competencies instudents appropriate for their professional careers.

Course Outcomes:
After the successful completion of course, the students will be able to:
CO1: Write clearly and fluently to produce effective technical documents.
CO2: Demonstrate an appropriate communication style to different types of audiences both orally and written as per demand of their professional careers.
CO3: Communicate in an ethically responsible manner.

Course Contents:

WRITING SKILLS

Unit-I (4 hours)
Technical Writing-Basic Principles: Words-Phrases-Sentences, Construction of Cohesive Paragraphs, Elements of Style.

Unit-II (4 hours)
Principles of Summarizing: Abstract, Summary, Synopsis

Unit-III (6 hours)
Technical Reports: Salient Features, Types of Reports, Structure of Reports, Data Collection, Use of Graphic Aids, Drafting and Writing

PRESENTATION SKILLS

Unit-IV (6 hours)

Unit-V (8 hours)

References:
Syllabus

ADVANCED FOUNDATION ENGINEERING (CET-609)

3L: 0T:0P                                                                                                                                         Credit: 3

Course Objectives: The objectives of this course are to impart knowledge and abilities the students to:
· Design a shallow foundation subjected to eccentric & inclined loads.
· Design of deep foundation i.e., piles based on settlement & bearing capacity criteria.
· Impart knowledge on earth pressure theories in design of gravity and cantilever retaining wall.
· Narrate the importance of apparent earth pressure diagrams in design of sheet piles & braced cuts.
· Design of foundations in Expansive soils.

Course Outcomes: After the completion of this course, the student will be able to:
1. Determine the earth pressures on foundations and retaining structures.
2. Analyze shallow and deep foundations.
3. Calculate the bearing capacity of soils and foundation settlements.

Syllabus:

UNIT-I                                                                                                                                         (8 hours)
Planning of Soil Exploration for different projects, methods of subsurface exploration, methods of borings along with various penetration tests.

UNIT-II                                                                                                                                         (8 hours)
Shallow Foundations: Requirements for satisfactory performance of foundations, methods of estimating bearing capacity, settlements of footings and rafts, proportioning of foundations using field test data, IS codes.

UNIT-III                                                                                                                                        (8 hours)
Pile Foundations: Methods of estimating load transfer of piles, settlements of pile foundations, pile group capacity and settlement, negative skin friction of piles, laterally loaded piles, pile load tests, analytical estimation of load - settlement behavior of piles, proportioning of pile foundations, lateral and uplift capacity of piles.

UNIT-IV                                                                                                                                         (8 hours)
Well Foundation: IS and IRC Codal provisions, elastic theory and ultimate resistance methods.

UNIT-V                                                                                                                                         (8 hours)

Text Book:

Reference Books:
Syllabus

SUBSURFACE INVESTIGATION AND INSTRUMENTATION (CET-511)

3L: 0T:0P  Credit: 3

Course Objectives:
- Students are expected to understand the importance of site investigation, planning of sub soil investigation, interpretation of investigated data to design suitable foundation system.

Course Outcomes: After the completion of this course, the student will be able to:
1. Describe the phases of soil investigation in depth and identify the plan for soil investigation.
2. Identify various methods of soil investigation and soil sampling.
3. Illustrate various field test of soils and rocks.
5. Work with relevant instrumentation required for characterizing the soil.

Syllabus:

UNIT-I  (8 hours)

UNIT-II  (8 hours)
Methods of Investigations and Sampling: Trial pits/Trenches, Borings/drilling, Auger boring, Wash boring, Percussion drilling, Rotary drilling, Sample Disturbance, Disturbed Sample, Undisturbed Samples, Sampling by standard split spoon, Sampling by thin-wall tube, Sampling by Piston sampler.

UNIT-III  (8 hours)
Geotechnical Investigation (Semi-direct methods): Vane Shear test, Standard Penetration Test, Pressuremeter Test, Cone Penetration Test, Dilatometer test, Rock core drilling, Sampling of rock, Core stacking, Rock Quality Designation (RQD), Total Core Recovery (TCR).

UNIT-IV  (8 hours)

UNIT-V  (8 hours)
Soil Exploration Report and Field Instrumentation: Components of Soil Exploration Report, Drafting of Reports, Graphic Presentations of Bore Log, Study of Sample Reports, And Field Instrumentation: Pressure meters, Piezometer, Pressure cells, Sensors, Inclinometers, Strain gauges etc.

Text Book:

Reference books:
4. Latest version of relevant IS codes for various tests.
Course Objectives:
The objectives of the course are for the students to develop an understanding of the engineering properties of rocks, geological and engineering rock classifications, rock failure theories, in-situ stresses in rock, and the fundamental concepts and principles of rock mechanics. This course is the pre-requisite for Rock Mechanics II which covers the applications of rock mechanics principles in the design of foundations, slopes and underground openings in rock.

Course Outcomes: After the completion of this course, the student will be able to:
1. Comment upon the behaviour of in-situ stresses.
2. Interpret different failure criteria.
3. Describe the laboratory investigation of shear strength of rock joints.
4. Analyse the stability of slopes in rocks.
5. Propose foundation on rocks.
6. Explain the underground excavation methods.
7. Select support system for excavation in rocks.

Syllabus:
UNIT-I (8 hours)
Physical Properties and Classification- Types of rocks and their formations; Distribution of Rocks in Indian Mainland; Laboratory Testing of Rocks; Strength, Modulus and Stress-Strain Response of Rocks; Engineering Classification of Rocks.

UNIT-II (8 hours)
In-situ Stress Conditions- In-situ stresses; Deformability tests in rock mass; Field shear test; Hydrofracturing technique, Flat jack technique; Estimation of Stresses in Rock Mass; Underground opening in infinite medium, Elastic and Elasto-Plastic approach. Stress concentration for different shapes of opening, Zone of influence.

UNIT-III (8 hours)
Failure Criteria- Failure criteria for rock and rock masses; Mohr-Coulomb Yield Criterion, Drucker-Prager Criterion, Hoek-Brown Criterion, Tensile Yield Criterion; Strength and deformability of jointed rock mass; Fracture strength of jointed rock mass; Shear strength of Rock joints, Deformability of Rock joints, Concept of joint compliance.

UNIT-IV (8 hours)

UNIT-V (8 hours)
Excavation Methods and Design of Support- Drilling and Blasting for Underground and Open Excavation; Stages of Excavation; TBM; Methods to improve rock mass responses.

Text Book:
VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

Syllabus

ENGINEERING ROCK MECHANICS (CET-610)

3L: 0T:0P

Credit: 3


Reference books:
Course Objectives: Objectives of introducing this subject are:
1. Explain the effects of pollutants in soil properties.
2. Awareness about the adverse effects of soil and ground water contaminants.
3. Analyse and apply the various techniques for remediation of the contaminants.

Course Outcomes: After the completion of this course, the student will be able to:
1. Understand soil environment interaction, composition, soil structure and its behaviour.
2. Specify site investigation techniques for characteristics of contaminated site.
3. Identify contaminant transport mechanisms in soils.
4. Specify site investigation techniques for characterization of contaminated site.
5. Understand the principles of soil treatment techniques.
6. Identify contaminants transport mechanism in soil.

Syllabus:

UNIT-I (8 hours)
Soil as a Multiphase System- Soil-environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium.

UNIT-II (8 hours)
Soil Mineralogy- significance of mineralogy in determining soil behaviour; Mineralogical characterization.

UNIT-III (8 hours)
Mechanisms of Soil-Water Interaction- Diffuse double layer models; Force of attraction and repulsion; Soil-water-contaminant interaction; Theories of ion exchange; Influence of organic and inorganic chemical interaction.

UNIT-IV (8 hours)
Concepts of Waste Containment- Sources, production and classification of wastes, Environmental laws and regulations, physico-chemical properties of soil, ground water flow and contaminant transport, desirable properties of soil; contaminant transport and retention; contaminated site remediation.

UNIT-V (8 hours)
Soil Characterization Techniques- volumetric water content; gas permeation in soil; electrical and thermal properties; pore-size distribution; contaminant analysis. contaminated site characterization, estimation of landfill quantities, landfill site location, design of various landfill components such as liners, covers, leachate collection and removal, gas generation and management, ground water monitoring, end uses of landfill sites, slurry walls and barrier systems, design and construction, stability, compatibility and performance, remediation technologies, stabilization of contaminated soils and risk assessment approaches.

Text Book:

Reference Books:
6. Dekker Inc.
Syllabus

MARINE GEOTECHNIQUES (CET-612)

3L: 0T:0P Credit: 3

Course Objectives:

To understand differences between the soil and loading conditions of on-shore and offshore structures, various types of offshore foundation systems, and to evaluate the performance of offshore structures.

Course Outcomes: After the completion of this course, the student will be able to:

1. Analyze distribution of marine sediments along the Indian coasts.
2. Analyze geotechnical challenges in case of marine sediments.
3. Implement in-situ testing procedures for determining the properties of marine clays.
4. Analyze behavior of marine soil deposits under repetitive loading conditions.

Syllabus:

UNIT-I (8 hours)
Marine soil deposits: Offshore environment, offshore structures and foundations, Specific problems related to marine soil deposits, Physical and engineering properties of marine soils.

UNIT-II (8 hours)
Behavior of soils subjected to repeated loading: Effect of wave loading on offshore foundations, Behavior of sands and clays under cyclic loading, Laboratory experiments including repeated loading, Cyclic behavior of soils based on fundamental theory of mechanics, Approximate engineering methods which can be used for practical cases.

UNIT-III (8 hours)
Site Investigation in the case of marine soil deposits: Challenges of site investigation in marine environment, Different site investigation techniques, sampling techniques, Geophysical methods, recent advancements in site investigation and sampling used for marine soil deposits.

UNIT-IV (8 hours)
Foundations in marine soil deposits: Different offshore and nearshore foundations, Gravity platforms, Jack-up rigs, pile foundations, cassions, spudcans.

UNIT-V (8 hours)
Numerical modeling of marine foundations subjected to wave loading: Numerical modeling of cyclic behavior of soils, empirical models, elastic-plastic models, FEM analysis of marine foundations subjected to wave loading.

Text Book:

Reference books:
VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

Syllabus

CONSTITUTIVE MODELLING IN GEOMECHANICS (CET-613)

3L: 0T:0P                                                                                                                         Credit: 3

Course Objectives: The course you will be able to:
- Understand principles and applications of methods available for modelling soil behavior.
- Recognize advantages and limitations of the different constitutive models.
- Understand how to select appropriate model parameters from available field and laboratory data.
- Understand how to apply a constitutive model using numerical methods (Finite Element Method, Finite Differences Method) available for engineering computer software (e.g., Plaxis, FLAC) to analyze a variety of geotechnical problems.

Course Outcomes: After the completion of this course, the student will be able to:
1. Summarise and compare the main features and uses of a constitutive model.
2. Select and justify parameters to be used in a constitutive model.
3. Implement constitutive modelling to assess the stability of a geotechnical structure.

Syllabus:

UNIT-I (8 hours)
Introduction to Constitutive Modelling- Importance of laboratory testing with relation to constitutive modelling; Stress/strain relationships, Elasticity: linear, quasi linear, anisotropic behavior.

UNIT-II (8 hours)
Simple Constitutive Models- Mohr-Coulomb models, Review s-t, p-q spaces, Introduction to critical state framework (with examples) with effects of pre-consolidation pressures and drained/undrained loading

UNIT-III (8 hours)
Modelling Aspects- Work done / energy balances, Plasticity, Normality rules and yield surfaces, Compare models with observed soil behaviours.

UNIT-IV (8 hours)
Extended Constitutive Models- Cam-clay models, Simulation of single element test using Cam-clay.

UNIT-V (8 hours)
Work Hardening Plasticity Theory- Formulation and implementation; Applications of elasto-plastic models; Special Topics: hypo elasticity-plasticity, disturbed state concept.

Text Book:

Reference books:
Course Objectives:
The students will learn theoretical aspects of tunnel and cavern excavation methods. The subject will help in understanding the applicability of excavation techniques with respect to ground conditions and its cost benefits.

Course Outcomes: At the end of the course, the student will be able to:
1. Understand the use of elastic and plastic analysis in the design of underground support system.
2. Know about the field tests generally conducted during and after construction of underground structures.

Syllabus:

UNIT-I
Introduction, planning of and exploration for various underground construction projects, stereographic projection method, principle and its application in underground excavation design.

UNIT-II
Elastic stress distribution around tunnels, stress distribution for different shapes and under different in-situ stress conditions, Greenspan method, design principles, multiple openings, and openings in laminated rocks, elasto-plastic analysis of tunnels, Daemen’s theory.

UNIT-III
Application of rock mass classification systems, ground conditions in tunneling, analysis of underground openings in squeezing and swelling ground, empirical methods, estimation of elastic modulus and modulus of deformation of rocks; uniaxial jacking / plate jacking tests, radial jacking and Goodman jacking tests, long term behaviour of tunnels and caverns, New Austrian Tunneling Method (NATM), Norwegian Tunneling Method (NTM), construction dewatering.

UNIT-IV
Rock mass-tunnel support interaction analysis, ground response and support reaction curves, Ladanyi’s elasto-plastic analysis of tunnels, design of various support systems including concrete and shotcrete linings, steel sets, rock bolting and rock anchoring, combined support systems, estimation of load carrying capacity of rock bolts.

UNIT-V
In-situ stress, flat jack, hydraulic fracturing and over coring techniques and USBM type drill hole deformation gauge, single and multi-point bore hole extensometers, load cells, pressure cells, etc. Instrumentation and monitoring of underground excavations, during and after construction, various case studies.

Text Book:

Reference books:
Syllabus

DESIGN OF UNDERGROUND EXCAVATIONS (CET-614)

3L: 0T:0P  credit: 3


Syllabus

EARTH RETAINING STRUCTURES (CET-513)

3L: 0T:0P                                                                                                                    Credit: 3

Course Objectives:
• To understand lateral earth pressure theories and pressure theories and design of retaining walls.
• To design anchored bulkheads by different methods.
• To understand pressure envelopes and design of various components in braced cuts and cofferdams.
• To understand stability of earth dams and its protection and construction.

Course Outcomes: At the end of the course, the student will be able to:
1. Analyze the earth retaining structures for their stability against earth pressure.
2. Apply engineering knowledge for the designing of earth retaining structures in various site conditions.
3. Evaluation of retaining structures using appropriate design methods, factors of safety, earth pressure diagrams and check their stability.
4. Determine the required depth of penetration and embedment of free and fixed sheet pile walls in cohesion and cohesionless soils.
5. Evaluate anchored sheet pile walls in free and fixed earth support conditions, spacing between bulkheads and anchors, resistance of anchor plates.

Syllabus:
UNIT-I (8 hours)
Earth Pressure- Introduction to earth pressure – basic concepts, Earth Pressure Types, Rankine’s theory, backfill features – soil type, surface inclination, loads on surface, soil layers, water level, Coulomb’s theory, Effects due to wall friction and wall inclination, Graphical methods and their interpretations.

UNIT-II (8 hours)

UNIT-III (8 hours)
Sheet Piles and Bulkheads- Sheet Piles and Bulkheads in Granular and Cohesive Soils - Materials Used for Sheet Piles – Free Earth and Fixed Earth Support Methods, Cantilever sheet piles, Anchored bulkheads, moment reduction factors, anchorage, Braced Excavation Types, Construction methods, Pressure distribution in sands and clays.

UNIT-IV (8 hours)
Seepage Analysis- seepage control in embankments and foundations, seepage analysis, stability analysis: upstream and down-stream for steady seepage, rapid draw down, end of construction, method of slices and Bishop’s method, Coffer dams: Braced coffer dams – walls and supports, bottom heave and piping, Arching in Soils - Soil Pressures on Braced Walls and their Design.

UNIT-V (8 hours)
Syllabus

EARTH RETAINING STRUCTURES (CET-513)

3L: 0T:0P Credit: 3


Reference books:
Course Objectives:
- To train the students with the latest and the best in the rapidly Risk management in the fields of Construction Engineering.
- To understand the concept of construction risks.
- How to recognize potential risks.
- To know how to quantify the likelihood and potential impact of risks.
- Analyze potential risks and create strategies.

Course Outcomes: After studying this course, you should be able to:
1. Demonstrate knowledge of the range of financial and financial related risks facing organizations.
2. Understand the approach to risk management through risk identification, risk measurement and risk management (or mitigation).
3. Understand reputational risk.
4. Be able to apply theoretical and practical aspects of risk management techniques to achieve project goals.
5. Be able to apply knowledge and skills of modern construction practices and techniques.

Syllabus:
UNIT-I Introduction: Concept risk management in construction, types of risks in risk management in construction, Importance of construction safety management, safety policy in construction. Study of safety policies, methods, equipment, training provided on any ISO approved construction Company, safety in office, working on sites of high-rise construction, deep excavation.

UNIT-II Risk analyses: Tools and techniques, impact Potential impacts in risk, risk impact charts mind tools, risk prioritization, probability and risk response strategies. Execute risk management in plan, involves member of the teams.

UNIT-III Construction safety management: Role of various parties, duties and responsibilities of top management, site managers, supervisor’s etc. role of safety officers, responsibilities of general employees, safety committee, safety training, incentives and monitoring. Writing safety manuals, preparing safety checklists and inspection reports.

UNIT-IV Safety in construction operations: Safety of accidents on various constructions sites such as buildings, dams, tunnels, bridges, roads, etc. safety at various stages of construction. Prevention of accidents. Safety measures. Safety in use of construction equipment e.g. Vehicles, cranes, hoists and lifts etc.

UNIT-V Safety of scaffolding and working platforms: Safety while using electrical appliances. Explosives used, various safety equipment and gear used on site. First aid on site, safety awareness program, labor laws, legal requirement and cost aspects of accidents on site, incentive for safety.
Syllabus

RISK MANAGEMENT IN CONSTRUCTION (CET-317)

3L: 0T:0P                                                                                                                    Credit: 3

Text Book:

Reference books:
4. ISI for safety in Construction – Bureau of Indian Standrads.
Course Objectives:
- To study the importance of EIA.
- To know the role of public in EIA studies.
- Understand phenomena of impacts in the environment.
- Know the impact quantification of various projects on the environment.

Course Outcomes:
1. Identify the objectives and scope of EIA.
2. Explicate the concept of EIA.
3. Illustrate the necessity of public participation in EIA studies.
4. Summarize the importance of Environmental Attributes.
5. Explain the phenomena of Impacts on environment.
6. Quantify impacts for various developmental projects.

Syllabus:
UNIT-I (8 hours)
Introduction to EIA: Definition, Evaluation of EIA in INDIA, Rapid and Comprehensive EIA, EIA, EIS, FONSI and NDS. Need for EIA studies, Baseline data, and Step-by-step procedure for conducting EIA, Advantages and Limitations of EIA, Hierarchy in EIA, Statutory requirements in EIA, MoEF guidelines in siting Developmental Projects.

UNIT-II (8 hours)
Objectives and Scope of EIA: Contents of EIA, Methodologies and Evaluation Techniques of EIA, Selection for specific projects.

UNIT-III (8 hours)

UNIT-IV (8 hours)

UNIT-V (8 hours)

Text Book:

Reference books:
Syllabus
ENVIRONMENTAL IMPACT ASSESSMENT (CET-318)

3L: 0T:0P Credit: 3

4. Guidelines for EIA of Developmental Projects, MoEF, GOI.
5. Environmental Quality management, south asian publishers pvt ltd., Bindu N. Lohani.
Syllabus

INDUSTRIAL SAFETY (CET-319)

3L: 0T:0P                                                                                                                               Credit: 3

Course Objectives:
- To know about Industrial safety programs and toxicology, Industrial laws, regulations and source models.
- To understand about fire and explosion, preventive methods, relief and its sizing methods.

Course Outcomes: By the end of the course the students will be able to:
1. Analyze the effect of release of toxic substances
2. Understand the industrial laws, regulations and source models.
3. Apply the methods of prevention of fire and explosions.
4. Understand the relief and its sizing methods.

Syllabus:

UNIT-I (8 hours)
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT-II (8 hours)
Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III (8 hours)

UNIT-IV (8 hours)
Fault tracing: Fault tracing-concept and importance, decision treeconception, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment’s like, i. Any one machine tool, ii. Pump iii. Air compressor, IV. Internal combustion engine, v. Boiler, VI. Electrical motors, Types of faults in machine tools and their general causes.

UNIT-V (8 hours)
Syllabus

INDUSTRIAL SAFETY (CET-319)

3L: 0T:0P                                                                                                                               Credit: 3

Text Book:

Reference books:
Course objectives: This course enables the students to:
- To have a practical knowledge and hands on experience of advanced equipment’s.
- To evaluate bearing capacity from field tests.
- To analyse and predict the behavior of soil from the experimental results.

Course Outcomes:
After the completion of this course, the student will be able to:
1. Evaluate the bearing capacity of soil using SPT, Plate load test etc.
2. Conduct experiments to analyse and interpret results for geotechnical engineering design in plaxis.

Syllabus:

Experiments:
1. To determination the plate load test.
2. To determination the standard penetration test.
3. To determination the standard cone penetration test.
4. To determination the dynamic cone penetration test.
5. To determination the field vane shear test.
6. To determination the triaxial test.
7. To know about the application of Plaxis software.
Syllabus

SUBSURFACE INVESTIGATION AND INSTRUMENTATION LAB (CEP-604)

0L: 0T:3P                                                                                                                               Credit: 1

Course objectives:
- To discuss the importance of site investigation.
- To narrate various exploration techniques.
- To describe soil sampling techniques.
- To train with in-situ sub soil exploration methods.
- To demonstrate instrumentation for sub soil exploration.

Course Outcomes: After the completion of this course, the student will be able to:
1. Perform various soil investigation tests.
2. Plan a soil investigation survey according to the structure and the sub-soil.
3. Choose the appropriate field instrumentation for a particular test.

Syllabus:
Experiments:
1. To study of various boring tools and techniques.
2. To study of various sampling tools.
3. To determine the Cone Penetration Test.
4. To determine the Pressure meter Test.
5. To determine the Dilatometer Test.
6. To determine the Seismic Refraction Test.
7. To determine the Electrical resistivity Test.
8. To determine the Study of Field Instrumentation.
Open Elective-2 (Optional)     AIR POLLUTION CONTROL ENGINEERING (CET-624)

3L: 0T:0P                                                                                                                                  Credit: 3

Course Objectives: Students will gain:
- The major problems in air pollution.
- About regulation pertinent to air pollution outcomes.
- How to control of air pollution.

Course Outcomes: Students will be able to:
1. Understand the fundamentals of origin, impacts and control of different air pollutants.
2. Explain the types, nature and behavior of air pollutants under the influence of atmospheric conditions.
3. Appraise the monitoring techniques and control measures to curb the air pollution, considering the standards limits.
4. Understand the technical aspects sound waves and controlling methods for vibration and noise pollution.

Syllabus:
UNIT-I                                                                                                                                      (8 hours)
Air Pollution Control, Air Pollution Effects, Effects of Air Pollution on Human Health Air Pollution Control Laws and Regulations, Emission Standard, Air Quality Standard.

UNIT-II                                                                                                                                 (8 hours)
Emission Estimates, Concentration Determination, Averaging, Standard Analytical Methods, isokinetic Sampling, Meteorology, Horizontal and Vertical Motion in the Atmosphere, Atmospheric Stability.

UNIT-III                                                                                                                                    (8 hours)
Fixed-Box, Diffusion model, Gaussian Plume Derivation, Plume Rise, Pollutant Creation and Decay in the Atmosphere Air Pollution Control, Process Change, Pollution Prevention, Downstream Pollution Control Device.

UNIT-IV                                                                                                                                    (8 hours)

UNIT-V                                                                                                                                     (8 hours)
Text Book:

Syllabus

Open Elective-2 (Optional)       AIR POLLUTION CONTROL ENGINEERING (CET-624)

3L: 0T:0P                                                                                                                                  Credit: 3


Reference Books:
Syllabus
Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0

Course Objectives: Students will be able to:
1. To understand the fundamentals of research in today’s world controlled by technology, ideas, concept, and creativity.
2. To understand different methods of research designing and data collections.
3. To understand the methods of report writing and its different methods of interpretations.
4. To understand research ethics and methods of research publications
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Course Outcomes:
1. To understand research problem formulation.
2. To study research design and method of data collections.
3. To study methods of report writing.
4. To follow research ethics.
5. To enhance student’s competence to discover new inventions.

Syllabus Contents:

UNIT 1: FUNDAMENTAL OF RESEARCH
Meaning of research; objectives of research; basic steps of research; criteria of good research; Research methods vs. Methodology. Types of research –criteria of good research; Meaning of research problem; selection of research problem; Approaches of investigation of solutions for research problem, Errors in selecting a research problem, Scope and objectives of research problem, Review of related literature- Meaning, necessity and sources.

Unit 2: RESEARCH DESIGN AND DATA COLLECTION
Research design: Types of research design- exploratory, descriptive, diagnostic and experimental; Variables- Meaning and types; Hypothesis- Meaning, function and types of hypothesis; Null/Alternative hypothesis; Sampling- Meaning and types of sampling; Probability and Non-Probability; Tools and techniques of data collection- questionnaire, schedule, interview, observation, case study, survey etc.

Unit 3: REPORT WRITING AND ITS INTERPRETATION
Syllabus
Research Methodology and IPR (AHT-302)

L:T:P:: 2:0:0  

Credits-2

Unit 4: RESEARCH ETHICS AND SCHOLARY PUBLISHING

Ethics-ethical issues, ethical committees (human & animal); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism and its concept and importance for scholar.

Unit 5: INTELLECTUAL PROPERTY RIGHT (IPR)


Reference Books:

2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”